Chem2110 Test 2
1 December, 2011

Time: 2 Hours

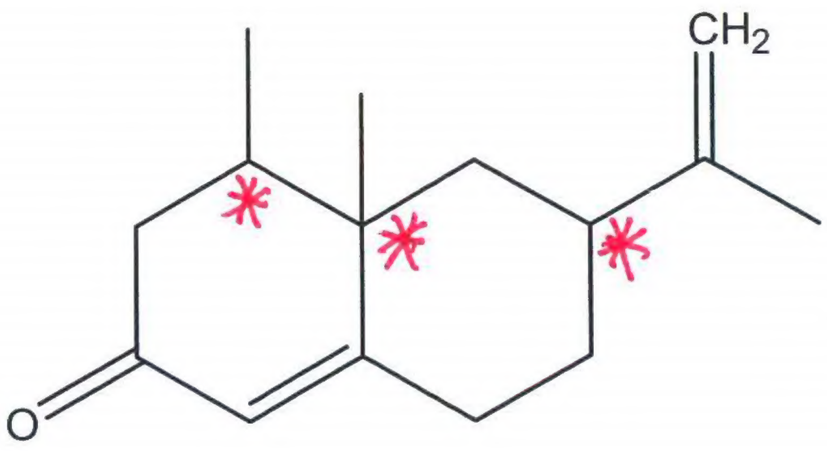
NAME: MODEL ANSWERS **ID NUMBER:** _____

1 **H** 1.008																	2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La*** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226	89 **Ac**† (227)															

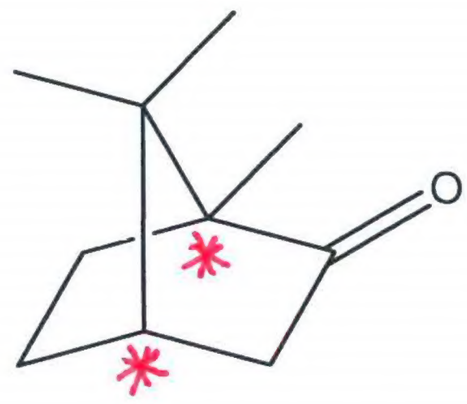
	Maximum Marks	Score
Total		

QUESTION 1

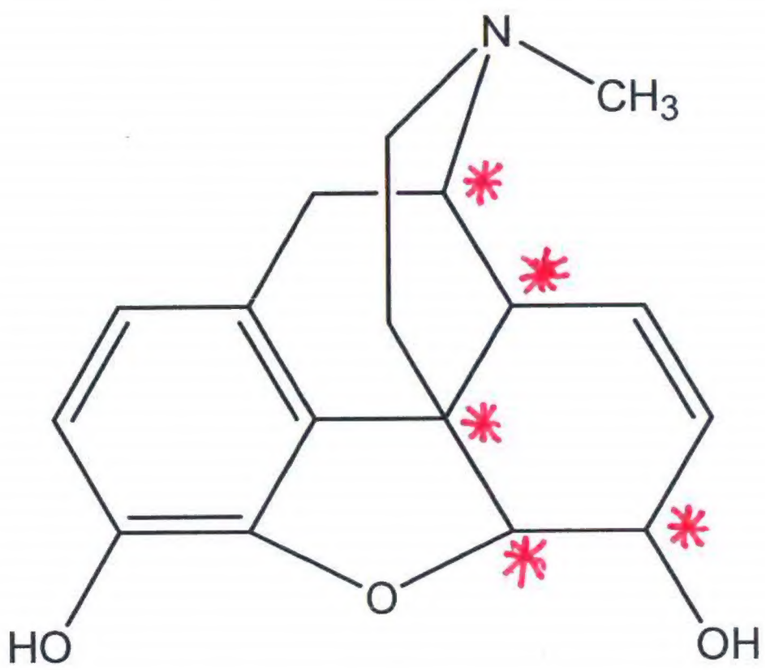
(a) Study the following biomolecules carefully and answer the questions that follow.



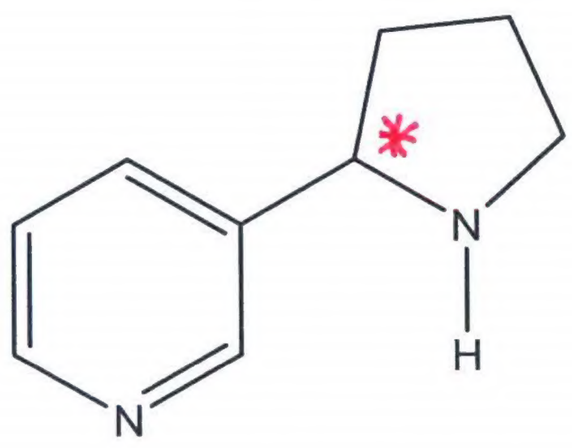
grapefruit oil



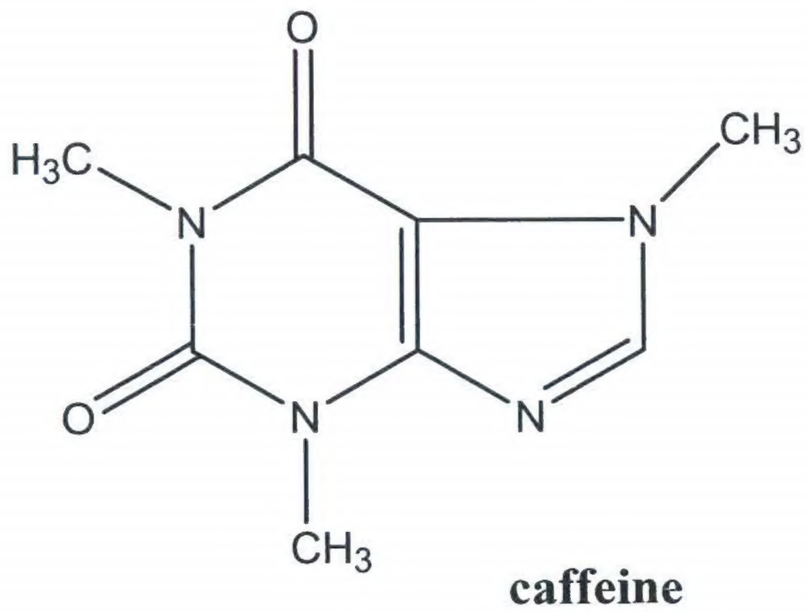
camphor



morphine



nicotine



caffeine

(i) Explain the meaning of the term ***functional group***.

YOUR NOTES

READ

(ii) Name all the functional groups in the following biomolecules:

Morphine

Nicotine

Caffeine

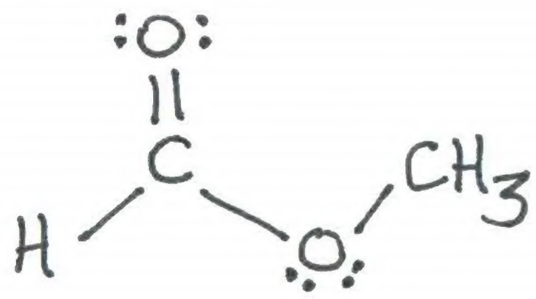
See page 2

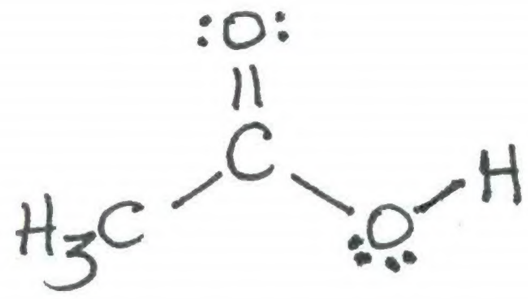
(iii) Give the number of **stereogenic centres** in the following biomolecules:

Morphine	5
Nicotine	1
Caffeine	0
Camphor	2
Grapefruit oil	3

(iv) Draw all possible structures of substances that have the molecular formula $C_2H_4O_2$ with only one functional group in each one of them.

(4)





Name the functional groups present in these substances.

(2) an ester and a carboxylic acid

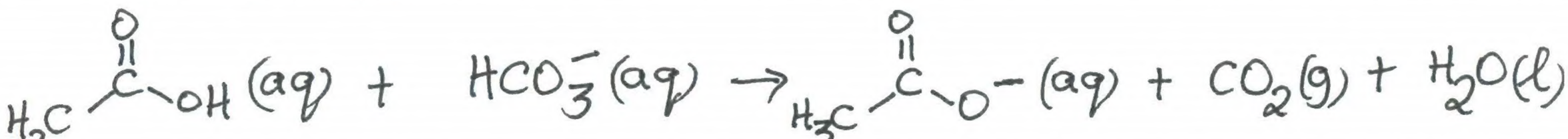
What is the relationship between these substances?

(1) These are constitutional/structural isomers

(2) (2) They both contain a carbonyl group

In the organic laboratory, what chemical test would you carry out to distinguish between these substances? Write a reaction equation for the chemical test.

(4) A simple chemical test would be to add sodium bicarbonate to each of their solutions. Acetic acid should react with the bicarbonate ions to produce carbon dioxide and water. The ester will not.



Which of these substances would you expect to have the highest boiling point? **Explain**.

(4) The carboxylic acid is expected to exhibit a higher boiling point than the ester because it has greater intermolecular forces. While the ester has only dispersion and dipole-dipole forces, the carboxylic acid has dispersion and dipole-dipole forces as well as strong hydrogen bonding (O–H···O) ∈ intermolecular H-bonding

(v) Explain the use of Tollens's reagent in the organic laboratory.

Tollens's reagent is used in the diagnostic test for aldehydes. It distinguishes aldehydes from ketones in that the Ag^+ ions oxidise the aldehyde but not the ketone.

(3)

In this test the Ag^+ ions are reduced to Ag metal and a silver mirror appears on the walls of the reaction vessel, indicating a positive test for an aldehyde

(vi) In many countries, car accidents are caused by drunk drivers.

Explain briefly, with the aid of reaction equations, how traffic police use a breathalyzer to Test if drivers are drunk or not.

The breath of a drunk driver contains high levels of an alcohol (ethanol). The alcohol is readily oxidised by dichromate ions to form an aldehyde or carboxylic acid. The $Cr_2O_7^{2-}$ ions are reduced to Cr^{3+} with a colour change. The breathalyzer contains $Cr_2O_7^{2-}$ ions $\Rightarrow$ a colour change is indicative of a positive test.

(4)

(vii) Write short notes on **soaps and their cleaning action**.

Soaps are carboxylate salts of fatty acids, e.g. sodium stearate $\Rightarrow$ $CH_3(CH_2)_{16}COO^-Na^+$

$\Rightarrow$ amphipathic with a long aliphatic hydrophobic tail and a hydrophilic head which is water-soluble

(4)

$\Rightarrow$ the hydrophobic tail interacts with the nonpolar grease whereas the hydrophilic head interacts with the polar water solvent molecules

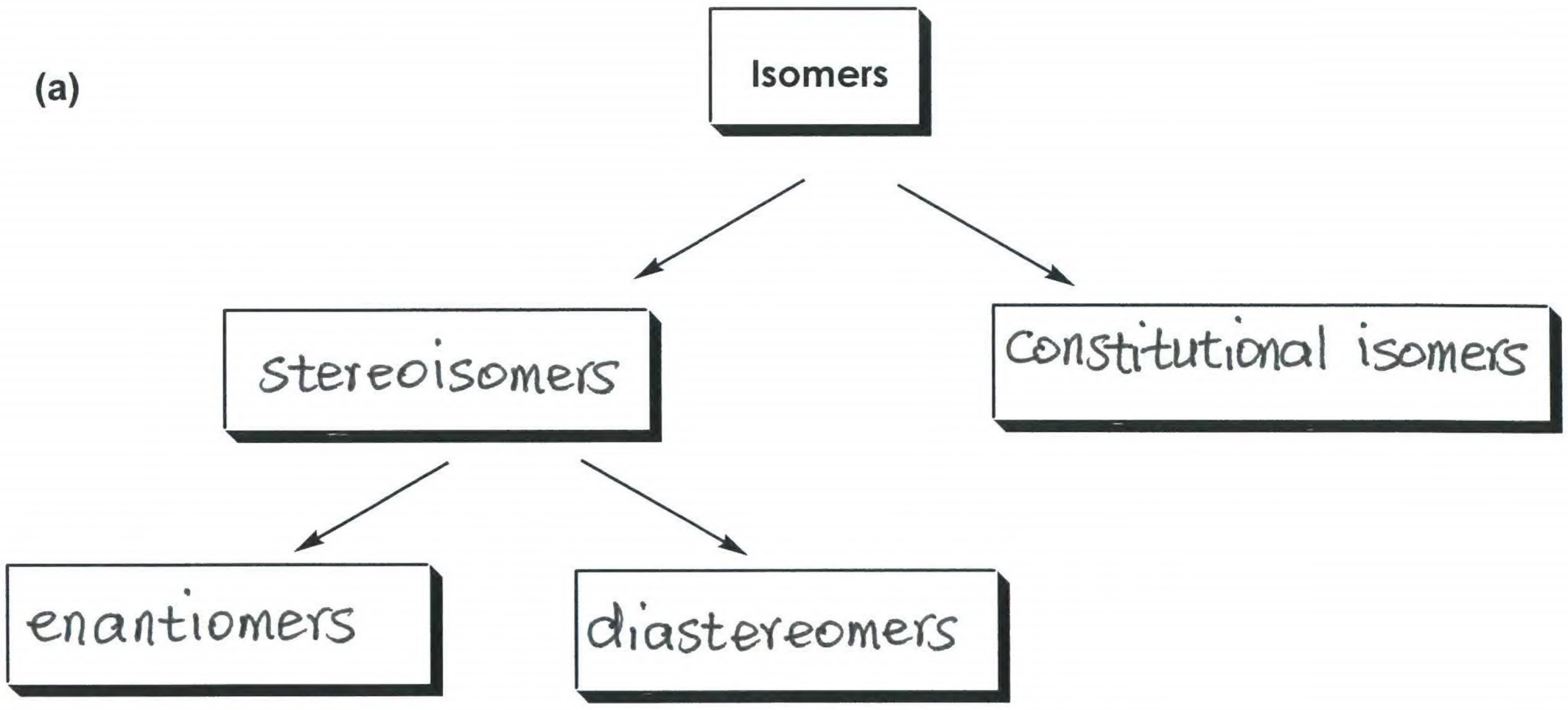
QUESTION 2

(46)

Complete the following charts:

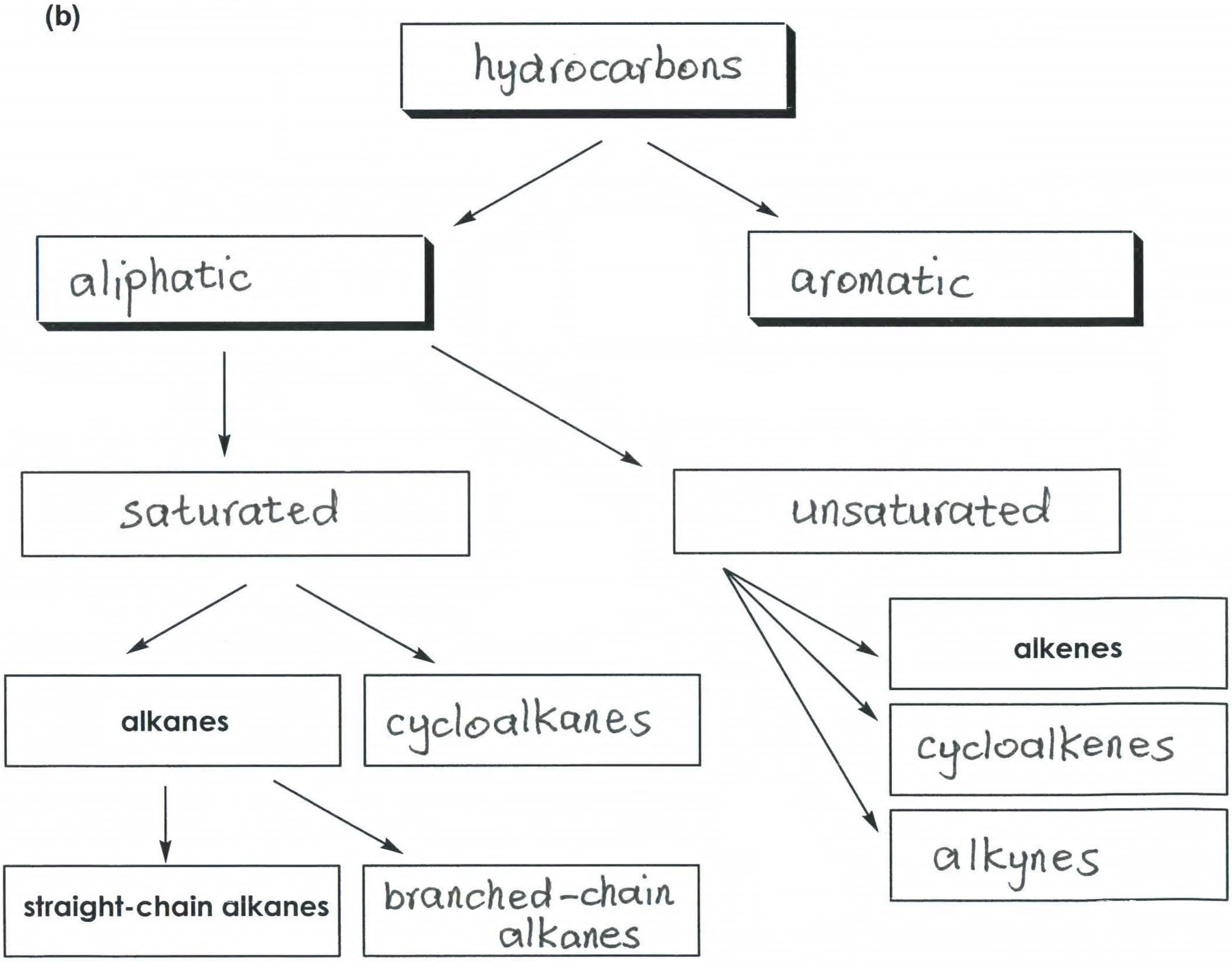
(a)

(4)



(9)

(b)



(c) Study the following reagents carefully:

RS^- $\cdot CH_3$ NH_2^- NO R_3N NO_2^+ OH^- BF_3 H_3O^+

(i) What type of bond cleavage produces an electrophile and a nucleophile? heterolytic bond cleavage (1)

(ii) From the list above, choose nucleophiles: RS^-, NH_2^-, R_3N, OH^- (4)

(iii) Electrophiles are also known as what? Lewis acids (1)

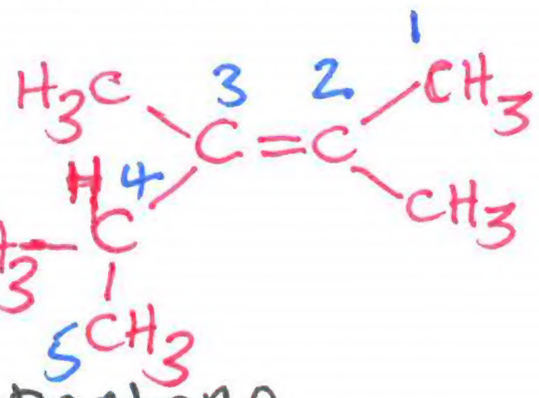
(iv) What type of reagent is NO? a free radical (1)
Explain. NO possesses an odd number of valence electrons. Therefore, its structure has an unpaired electron. (1)

(11) (d) Complete the following paragraph.

Chiral molecules have stereogenic centres and exhibit enantiomerism which is also known as optical isomerism because enantiomers are optically active. Enantiomers of a given compound are nonsuperimposable mirror images of each other. These enantiomers can be distinguished using an instrument called a polarimeter. They rotate plane-polarised light by ~~different tho same~~ the same amount in opposite directions. The enantiomer that rotates plane-polarised light to the right is described as dextrorotatory. Each enantiomeric compound has its own Specific rotation given by the symbol $[\alpha]_D$. Both enantiomers and diastereomers are stereoisomers because their atoms or groups of atoms differ in spatial orientation.

(29) (e) **Name** the following substances:

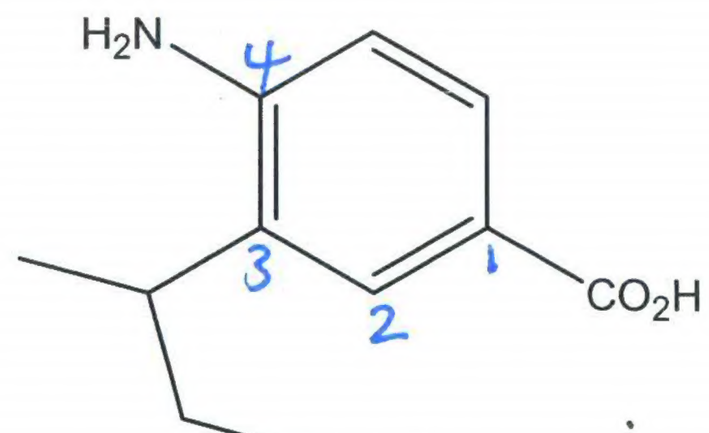
$CH_3C(=CH(CH_3)_2)CH(CH_3)_2$



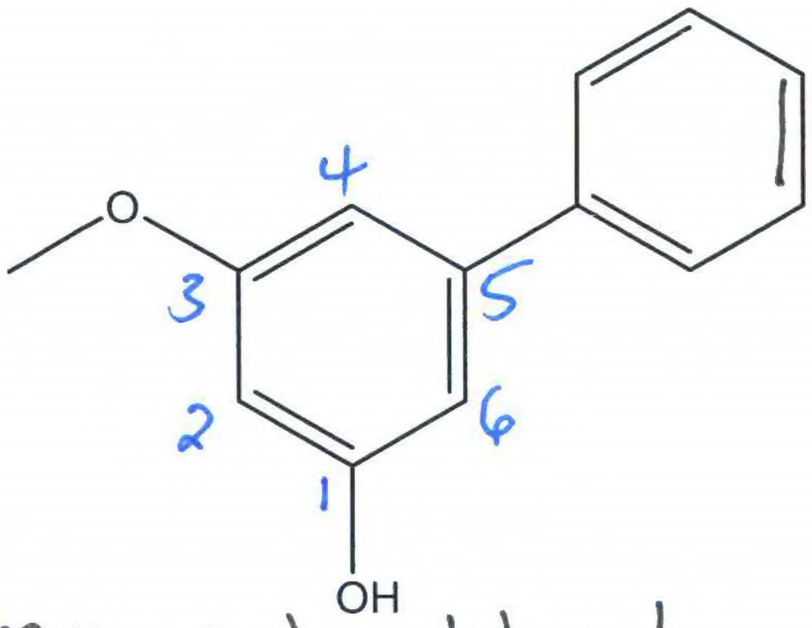
2,3,4-trimethyl-2-pentene

$CH_3CH(OH)CO_2H$

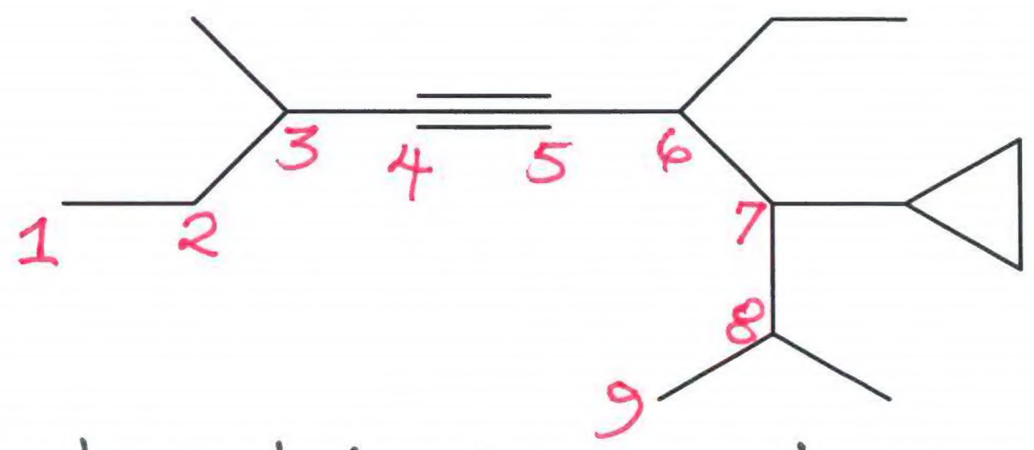
lactic acid



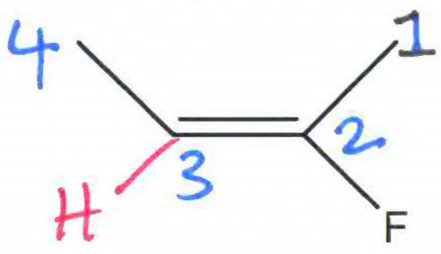
4-amino-3-sec-butylbenzoic acid



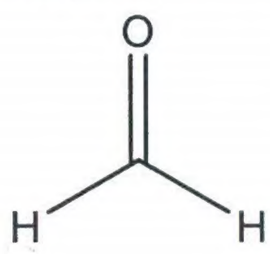
3-methoxy-5-phenylphenol



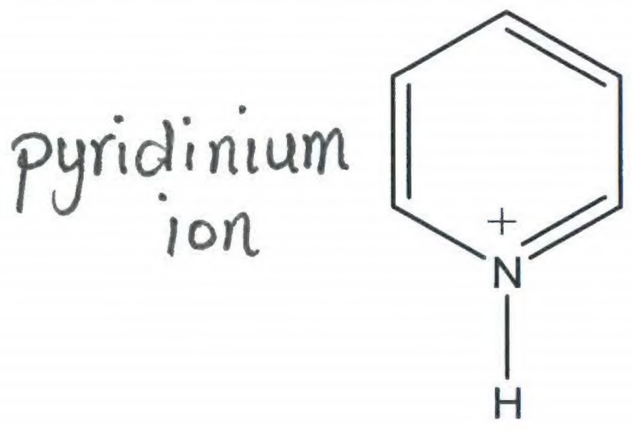
7-cyclopropyl-6-ethyl-3,8-dimethyl-4-nonyne



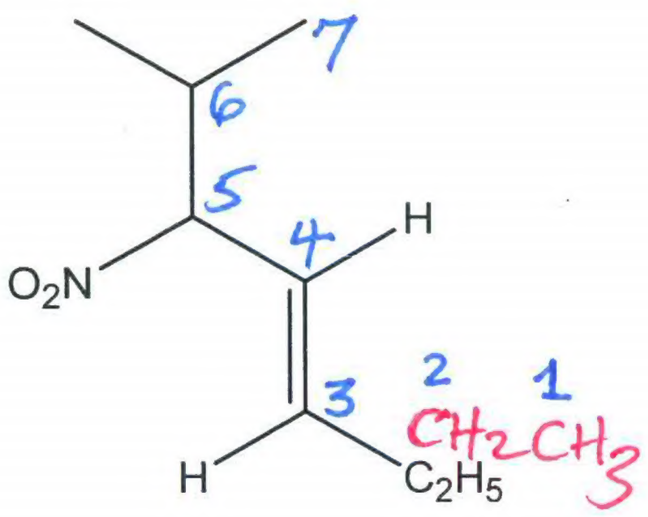
cis-2-fluoro-2-butene



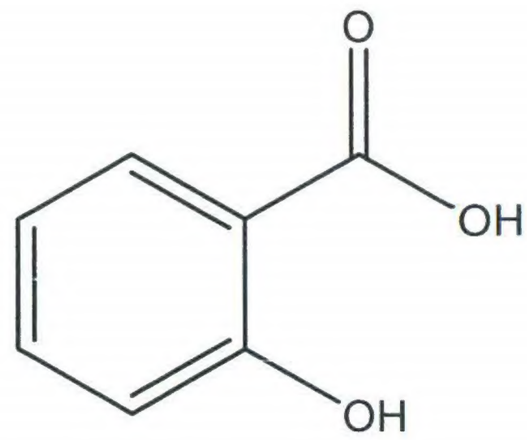
formaldehyde



pyridinium ion



trans-6-methyl-5-nitro-3-heptene



Three possible names:

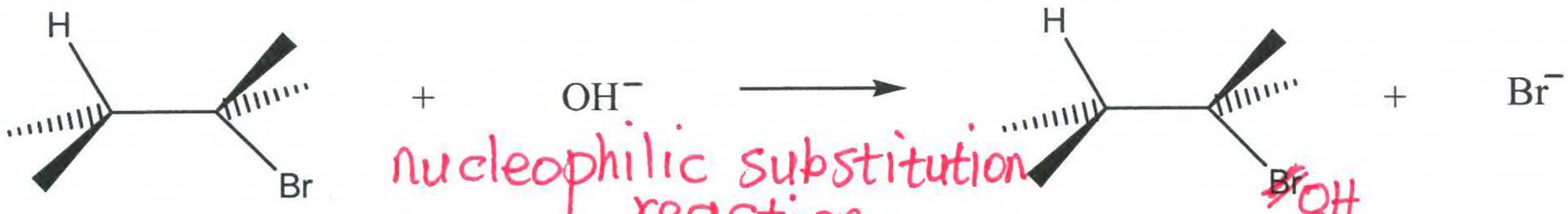
salicylic acid

o-hydroxybenzoic acid

2-hydroxybenzoic acid

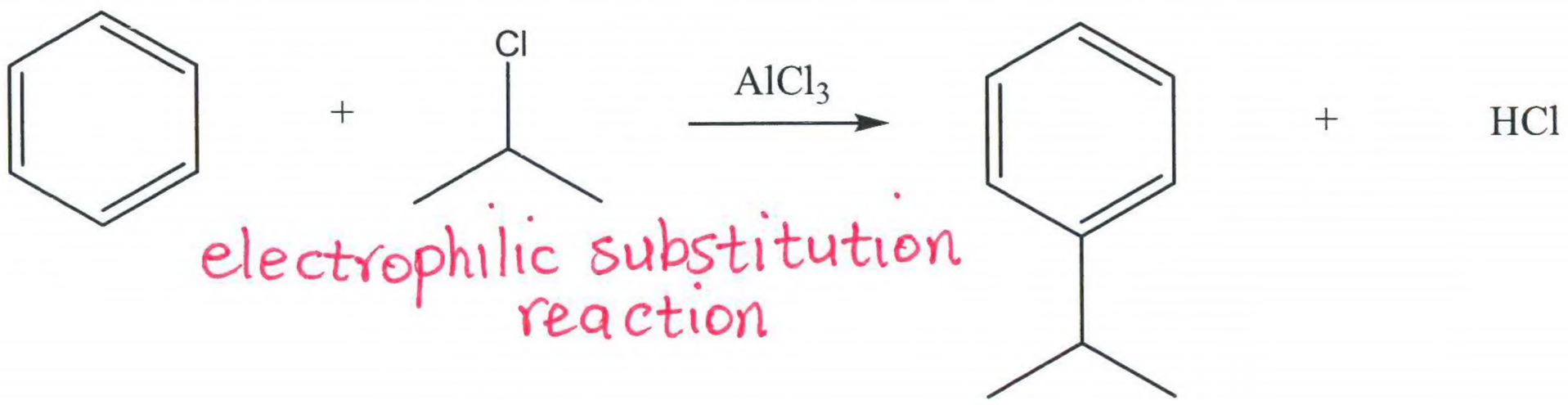
(16)

(f) **Name** the following chemical reactions:



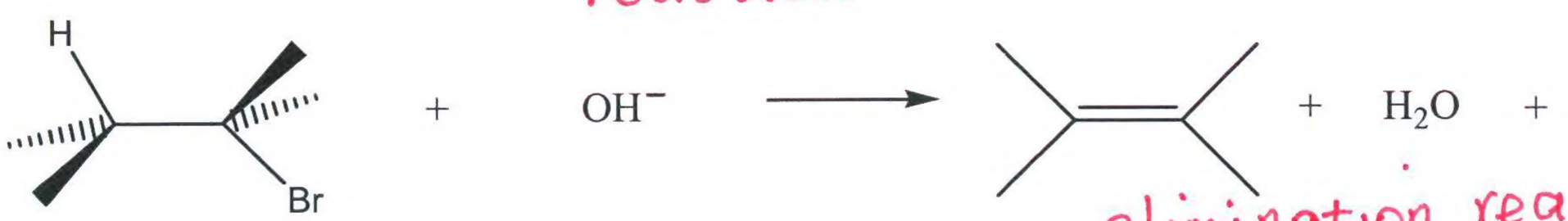
nucleophilic substitution reaction

cracking of an alkane

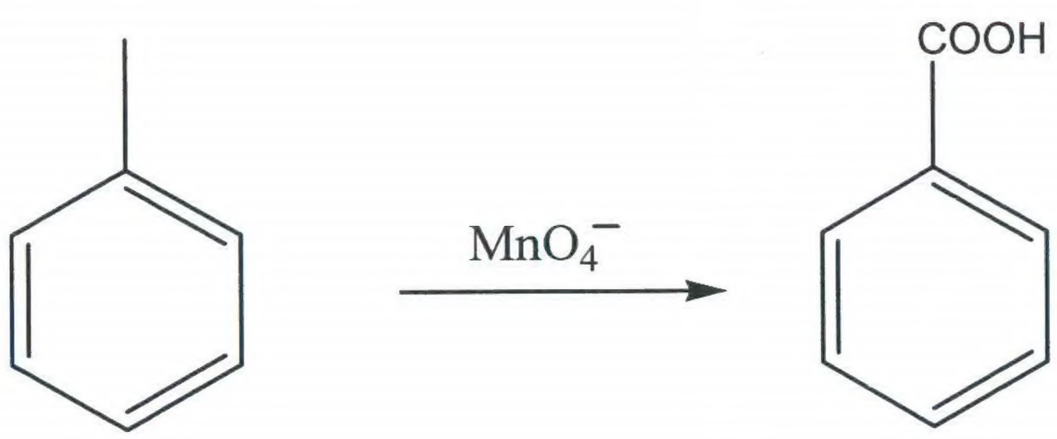


electrophilic substitution reaction

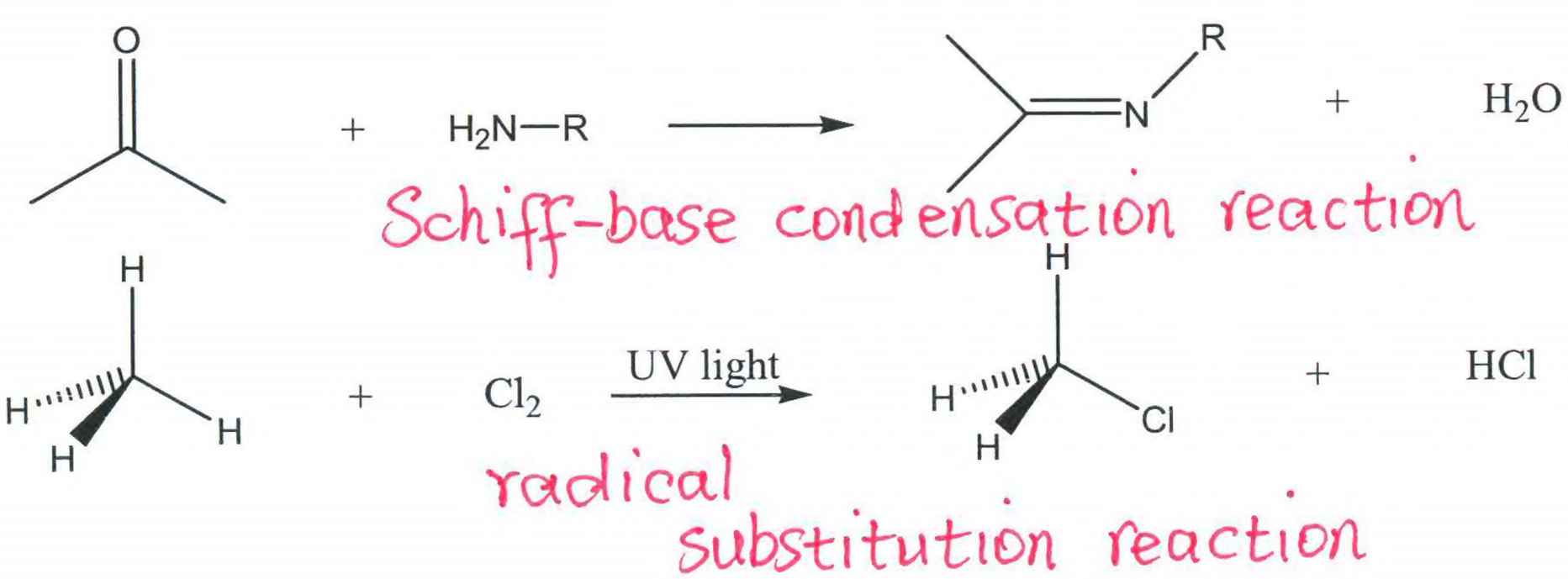
electrophilic addition reaction



elimination reaction



oxidation of toluene (alkyl benzene)



Schiff-base condensation reaction

radical substitution reaction